Chapter 2

Continuous Monitoring of Ozone

Chapter 2
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FIGURE

TABLE

APPENDIX

1.0 Introduction

It is the intent of this chapter to outline the requirements for the ambient air monitoring of ozone (O_3). All practices and procedures outlined follow the requirements set for in 40 CFR Parts 50, 53 and 58. All agencies or groups that conduct ozone monitoring within the state of Indiana and submit data to the Air Quality System (AQS) database must follow requirements in this chapter. Indiana's ozone monitoring season is April 1 through September 30.

Effective May 27, 2008, the United States Environmental Protection Agency (USEPA) established a new National Ambient Air Quality Standard (NAAQS) for ozone. The new standard is described as: the 3-year average of the annual 4th highest daily maximum 8-hour ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. This new standard will provide increased protection to the public; especially children and other at-risk populations. Some of these health effects include decreased lung function, increased respiratory symptoms, inflammation of the lung, and possible long-term damage to the lungs. Indiana is now in attainment for ozone state wide and no longer subject to the previous 1-hour standard of 0.12 ppm. The USEPA also replaced the secondary standard (to protect agricultural crops, national parks, and forests) with a standard identical to the new primary standard. http://epa.gov/oaqps001/greenbk/oindex.html

Currently all Indiana Ozone Monitoring Network analyzers are connected to the Leading Environmental Analysis Database System (LEADS). This Data Acquisition System (DAS) allows for remote access to the analyzers and site conditions providing information on:

- Diagnostics; such as:
  Flow
  Pressure
  Temperature

- Near Real Time Ambient Ozone levels

- Quality Control Activities such as:
  Daily zero/span checks
  Bi-weekly precision checks
  Multi-point calibrations
  Electronic operator log records retention

- Site Conditions like:
  Inside temperature
  Meteorological conditions

2.0 Probe Siting Criteria

For specific siting requirements for O_3 monitors and inlet probes, refer to Chapter 1 of this manual and to the Code of Federal Regulations (CFR) 40, Part 58, Appendixes D and E.

http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title40/40cfr58_main_02.tpl

2.1 Horizontal and Vertical Probe Placement

The ozone monitor inlet probe should be as close as possible to the breathing zone. Complicating factors may require that the probe be elevated. The sample inlet probe height must be 3 to 15 meters above ground level. The probe must also be located more than one meter vertically or horizontally away from any supporting structure.

2.2 Spacing from Obstructions

The probe must be located away from obstacles and buildings such that the distance between the obstacles and the inlet probe is at least twice the height that the obstacle protrudes above the probe. The probe would be considered to be obstructed if an imaginary line extended 30 degrees up from the horizontal and rotated 360 degrees intersects any obstruction within 30 meters. Airflow must be unrestricted in an arc of at least 270 degrees around the inlet probe and the predominant wind direction for the season of greatest pollutant concentration potential must be included in the 270 degrees arc. If the probe is located on the side of a building, 180 degrees of clearance is required.

2.3 Spacing from Roads

It is important to minimize the destructive interferences of nitric oxide (NO) since NO readily reacts with O_3 (see Table 2-1 for separation distances between roadways and monitoring stations). *The proximity of other NOx sources such as: coal fired furnaces, parking lots, or dispersion from agricultural operations.). Must also been taken in consideration when setting up an ozone monitoring location.*

Table 1
Minimum Separation Distance Between Neighborhood and Urban Scale Ozone Stations and Roadways

Average Vehicles per day	Minimum Separation (meters) *
≤ 10,000	10
15,000	20
20,000	30
40,000	50
70,000	100
≥110,000	250

* Distances should be interpolated based on traffic flow.

2.4 Spacing from Trees

Since the scavenging effect of trees is greater for O_3 than for other priority pollutants, strong consideration must be given to the location of an O_3 inlet probe. The sample probe must be at least 10 meters from the drip line of trees which are located in the predominant seasonal wind direction. Generally, the probe should be at least 20 meters from the drip line of trees in all directions.

3.0 Monitoring Methodology

All methods used to monitor O_3 must be a Federal Reference Method (FRM) or equivalent procedure described in 40 CFR Part 53. For all analyzers, refer to the manufacturer's instruction manual for specific requirements.

3.1 Monitoring Principle - Ultraviolet (UV) Absorption

This method used to monitor O_3, is based on the Beer-Lambert principle that O_3 absorbs ultraviolet light. The greatest absorbance takes place at the 253.7 nm wavelength. A low pressure mercury vapor lamp produces light at this wavelength. This light is admitted into a measuring cell. Ozonated (sample) air and non-ozonated (zero) air are alternately passed through the sample cell. The UV radiation passes through the sample and is absorbed by ozone. The strength of the UV signal detected after passing through the sample air is directly proportional to the O_3 concentration.

3.2 Monitoring Requirements

- The sample manifold and all contact sample lines and connectors must be borosilicate glass or Teflon.

- The analyzer reads mercury vapor as ozone, therefore the analyzer should not be placed in a facility where mercury contamination is possible (i.e. laboratories).

- Airflow to the monitoring system should be unrestricted.

- The incoming sample air should not be pressurized.

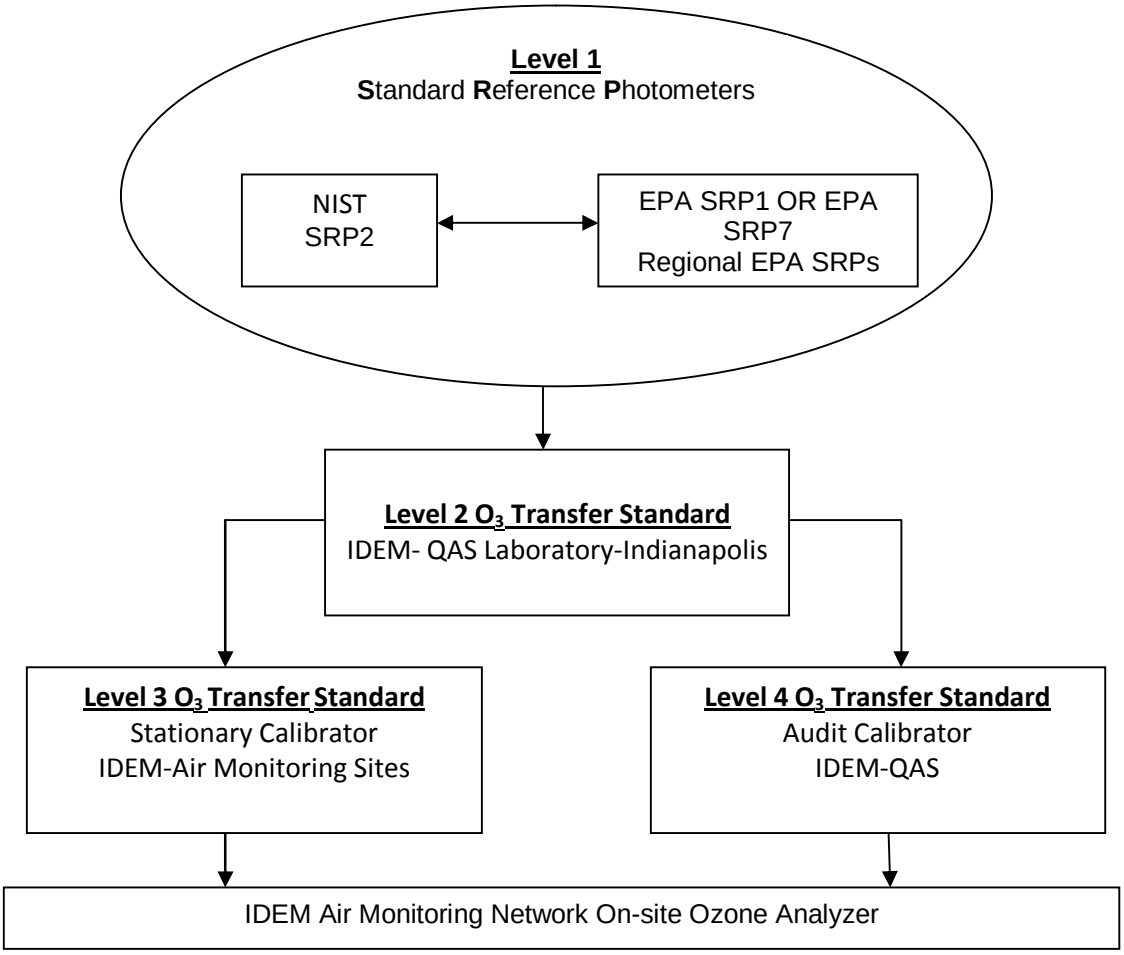
- The location of the monitor should be maintained at a temperature between 55^{o} and 86^{o} Fahrenheit.

4.0 Calibration Methodology

Once each year, prior to the beginning of the ozone monitoring season, the Office of Air Quality's (OAQ) Level 2 O_3 Transfer Standard is certified at the USEPA's Region V laboratory facility. There, the IDEM Level 2 O_3 Transfer Standard is compared to the EPA Level 1 Standard Reference Photometer.

A transfer standard is defined as a transportable device or apparatus which, together with associated operational procedures, is capable of accurately reproducing pollutant concentration standards (in this case, ozone) or of producing accurate assays of pollutant concentrations which are quantitatively related to a higher level and more authoritative standard. The transfer standard's purpose is to transfer the authority of a Level 1 pollutant standard (in this case, ozone) to a remote point where it is used to verify or calibrate an air monitoring analyzer. (see Figure 1).

Figure 1
Ozone Standard Tractability Ladder



Routine calibrations of the IDEM ozone monitoring network analyzers are preformed every six months using the on-site Level 3 O_3 transfer standard. Heretofore this term can be considered synonymous with: station calibrator.

The station calibrators are certified against the IDEM Level 2 O_3 transfer standard once each year in the IDEM QA laboratory. As long as the station calibrator remains at a fixed location and maintains good stability, recertification during the monitoring season is not necessary. For more information on transfer standards see Chapter 6 of this manual or consult: http://www.epa.gov/ttn/amtic/files/ambient/qaqc/OzoneTransferStandardGuidance.pdf

All calibrations must follow the guidelines established in 40 CFR Part 50 Appendix D.

4.1 Calibration Environment

In order to ensure an ozone calibration is done accurately, certain conditions must be met:

- The certification of the O_3 transfer standard must be current (see Chapter 6).
- The Level 3 O_3 transfer standard must have ample warm up time (15-30 minutes).
- The dilution air must be dry, free of nitrogen oxides, ambient O_3 and traces of mercury.
- The station temperature must be between 55° and 86° Fahrenheit.

4.2 Determination of Standard Concentration

Use the following formula to determine O_3 concentrations:

Standard Concentration = 1/slope x (Indicated O_3 Value - Intercept)

The slope and intercept are determined during the certification of the ozone transfer standard. See Chapter 6 of this manual for the certification procedures

4.3 Calibration Category

There are two types of calibrations: a Multi-point and a Level 1.

4.3.1 Level 1

On-site Level 1 Calibration

Manual field calibrations of ozone analyzers are preformed at the individual monitoring sites using the Level 3 certified station calibrator. The analyzer is challenged to sample test atmospheres containing a known concentration of ozone and zero air (zero/span). This is known as a Level 1 Calibration.

To perform an ozone field calibration, it is not necessary to change the set up of the calibrator delivery system. To begin the calibration:

- Log into the station laptop and access the data logger
- From the User menu, Press G to display channel identification numbers
- Press C and the ozone channel number/Q to disable the ozone channel and flag the data
- Press U to return to the User Menu

- Press: MENU on the analyzer, and using the arrow keys, select: INSTRUMENT CONTROLS
- Press: ENTER
- Using the arrow keys, select: SERVICE MODE
- Press: ENTER twice to turn ON the SERVICE MODE
- Press: MENU twice to return to the MAIN MENU
- Using the arrow keys, select: CALIBRATION
- Press: ENTER
- Select: CALIBRATE ZERO
- Press: ENTER
- Introduce zero air to the analyzer by setting the station calibrator to Level 60
- Allow for stabilization
- Press: ENTER to set the zero, the analyzer will automatically save the new zero value
- Press: MENU on the analyzer
- Using the arrow keys, select: CALIBRATE O_3
- Press: ENTER
- Introduce a concentration of .400 ppm ozone to the analyzer by setting the station calibrator to Level 66
- Allow for stabilization
- Using the arrow keys, set the analyzer ozone response to match the calibrator display
- Press: ENTER to save the setting
- Press: MENU twice to return to the MAIN MENU
- Using the arrow keys, select: INSTRUMENT CONTROLS

- Press: ENTER
- Using the arrow keys, select: SERVICE MODE
- Press: ENTER twice to turn OFF the SERVICE MODE
- Press: RUN on the analyzer to return to normal sampling mode
- Set the station calibrator to Level 99 to return it to STANDBY mode
- Enable the ozone channel on the station Zeno data logger and make the appropriate electronic operator log entries
- Schedule a remote multi point calibration with the IDEM- OAQ/AMB LEADS Administrator

4.3.2 Remote Multi-point Calibration

Currently all O_3 sites in the IDEM continuous air monitoring network are equipped with on-site Teledyne Advanced Pollution Instruments (API) mass flow calibrators. These units can be accessed remotely through the Leading Environmental Analysis and Display System (LEADS). Calibrations and certain quality assurance/quality control processes are conducted telemetrically on a routine pre-set schedule and/or on a by demand basis.

A Multi-point Calibration consists of three or more test concentrations which include:

- A zero concentration (pollution free air)
- A concentration between 80% and 90% of full range (or, approximately .400 ppm for a .500 ppm range ozone analyzer)
- One or more intermediate concentrations spaced approximately equal range (or, approximately .185 ppm and .090 ppm for a .500 ppm range ozone analyzer)

This multi-point calibration must be performed at the time of the initial installation and after a six month period has lapsed since the most recent multi-point calibration. All calibration points must be within ±2% of the full range of the analyzer (e.g., if the range is .500 ppm, then all measured values must be within ± .010 ppm of the introduced test concentration).

4.3.3 On-site Multi-point Calibration

Special case situations may arise which would require IDEM, an external contractor, local agency or industrial network to sample for ozone without advanced monitoring or data acquisition systems (DAS). In these cases it would be necessary to perform the multi-point calibration on site using the procedure outlined in Appendix 1.

4.3.3.1 Calibration Frequency

An on-site Level 1 Calibration of an analyzer should be performed on an analyzer if any of the following conditions exist:

- Following any repairs (replacement of electronic boards, optics, etc) that may affect the calibration
- Physical relocation of the analyzer

A Multi-point Calibration of an analyzer must be performed if:

- After initial installation
- At the beginning of each monitoring season
- After a six (6) month period has lapsed since the most recent Multi-point Calibration
- Any time zero span checks show significant drift indicating the current calibration may be have changed

A Multi-point Calibration may always be substituted for a Level 1 calibration

5.0 Quality Assurance Audits

Quality assurance audits are performed to ensure the validity of the data submitted. Results of these audits are also used to calculate the Precision and Accuracy (P&A) of a monitor or network. The Quality Assurance Section (QAS) submits quarterly reports of the statewide P&A data to USEPA through the Air Quality System database (AQS). See Chapter 13 of this manual for specific instructions on how to calculate and report P&A values.

5.1 Bi-weekly Precision Audits

Bi-weekly precision audits are done in accordance with 40 CFR Part 58 Appendix. Currently, all continuous ozone analyzers are routinely audited remotely through the LEADS, every two weeks during season of operation. Indiana's ozone season runs from April 1st through September 30th. These precision checks are scheduled by the OAQ/AMS/LEADS Administrator and are set to run at midnight when ambient ozone levels could be expected to be at a low. The bi-weekly precision audit consists of a validation or span check (.400 ppm O_3) a precision level check (.090 ppm O_3) and a zero concentration point.

On-site manual precision audits may be conducted by IDEM quality assurance staff on an as needed basis such as:

- LEADS communication malfunction
- Unstable or failing remote audit results

5.2 45-Day Ozone Calibrator Audits

Once every 45-day, IDEM quality assurance staff conduct audits of the on-site API ozone calibrators. The station API is manually set to run test concentrations (.400 ppm, .090 ppm and zero). The auditor then introduces similar concentrations with an independent Level 4 O_3 transfer standard. The results are compared and must agree within ±15% or corrective action is required and the data for the operational period is considered invalid. Corrective action may include but is not limited to:

- A multi-point remote calibration
- Replacement or recharge of the clean air scrubbers
- Inspection of all incoming and outgoing sample and ventilation lines
- Troubleshooting, repair or replacement of the analyzer or station calibrator (consult operation manuals for the specifics of troubleshooting and repair procedures)

5.2.1 Procedure

Part One – On-site Analyzer Audit

Once on site, to begin the audit:

- Plug in the Level 4 audit calibrator and allow for warm up (30 minutes)
- Log into the station laptop and access the data logger
- From the User menu, Press G to display channel identification numbers
- Press C and the ozone channel number/Q to disable the ozone channel and flag the data
- Press U to return to the User Menu
- Press T
- Press R/ozone channel number to view the current voltage output

- Open the Office of Air Monitoring Database (OAMD) O_3 Calibrator Audit form on the field laptop

- Fill in the appropriate information including:

    a) Site Name
    b) Auditor
    c) Date
    d) Start time
    e) Analyzer calibration slope
    f) Audit and On-site Calibrator serial numbers

- Introduce zero air to the analyzer by setting the Level 4 audit calibrator to zero

- Disconnect the incoming sample line at the manifold and cap the port

- Attach the incoming sample line to the output of the calibrator, venting if necessary

- Allow for stabilization

- Using a voltmeter, compare the Zeno output display (on the station laptop) to the voltage input from the ozone analyzer to the Zeno patch panel

- Enter the output and the calibrator zero response on the OAMD form. The Oracle spreadsheet will automatically calculate the Zeno output to parts per million ozone and display the % difference between the standard and observed concentration

- Introduce a test concentration of .400 ppm ozone to the analyzer by setting the Level 4 audit calibrator to 400 plus the zero response

- Allow for stabilization

- Using a voltmeter, compare the Zeno output display (on the station laptop) to the voltage input from the ozone analyzer to the Zeno patch panel

- Enter the output and the calibrator response on the OAMD form. The Oracle spreadsheet will automatically calculate the Zeno output to parts per million ozone and display the % difference between the standard and observed concentration

- Introduce a test concentration of .090 ppm ozone to the analyzer by setting the Level 4 audit calibrator to 090 plus the zero response

- Allow for stabilization

- Using a voltmeter, compare the Zeno output display (on the station laptop) to the voltage input from the ozone analyzer to the Zeno patch panel

- Enter the output and the calibrator response on the OAMD form. The Oracle spread sheet will automatically calculate the Zeno output to parts per million ozone and display the % difference between the standard and observed concentration

- Reconnect the incoming sample line to the manifold and disassemble the Level 4 audit calibrator

Part Two - On-site Calibrator Audit

To perform the calibrator portion of the 45-day audit, it is not necessary to change the delivery system of the calibrator. To begin the audit:

- Introduce zero air to the analyzer by setting the station calibrator to Level 60

- Allow for stabilization

- Using a voltmeter, compare the Zeno output display (on the station laptop) to the voltage input from the ozone analyzer to the Zeno patch panel

- Enter the output on the OAMD field form. The Oracle spread sheet will automatically calculate the Zeno output to parts per million ozone and display the % difference between the standard and observed concentration

- Introduce a test concentration of .400 ppm ozone to the analyzer by setting the station calibrator to Level 66

- Allow for stabilization

- Using a voltmeter, compare the Zeno output display (on the station laptop) to the voltage input from the ozone analyzer to the Zeno patch panel

- Enter the output on the OAMD form. The Oracle spreadsheet will automatically calculate the Zeno output to parts per million ozone and display the % difference between the standard and observed concentration

- Introduce a test concentration of .090 ppm ozone to the analyzer by setting the station calibrator to Level 62

- Allow for stabilization

- Using a voltmeter, compare the Zeno output display (on the station laptop) to the voltage input from the ozone analyzer to the Zeno patch panel

- Enter the output on the OAMD form. The Oracle spread sheet will automatically calculate the Zeno output to parts per million ozone and display the % difference between the standard and observed concentration

- Return the station calibrator to STANDBY mode by setting it to Level 99

- Allow the ozone analyzer to return to ambient conditions

- Enable the ozone channel and make the appropriate electronic operator logbook entries

- Enter the audit end time on the OAMD form and save the audit results

This completes the 45-day calibrator audit process. If the results do not pass both test concentration comparisons (>15%), notify the ambient monitoring section staff member currently responsible for ozone and determine the course of action.

5.3 Quarterly Accuracy Audit

Once each quarter during the monitoring season IDEM quality assurance staff conduct accuracy audits on each ozone analyzer in the network. This audit frequency is more than the U.S.EPA requires (40CFR Part 58, Appendix A). An accuracy audit consists of 3 test concentrations in the ranges listed below and a zero:

For analyzers set to sample in the 0-.5 ppm range:

- .190 - .259ppm O_3
- .140 - .169ppm O_3 and
- .070 - .089ppm O_3

To avoid duplication of effort, accuracy audits may be conducted at the same time the 45-day calibrator audit being conducted.

5.3.1 Procedure

The procedure outlined below is to be used for Indiana Ozone Monitors equipped with the LEADS. If the LEADS is not in service or another form of DAS is being utilized, flag the data with the appropriate information according to the procedure recommended by the specific DAS operations manual.

Once on site, to begin the audit:

- Plug in the Level 4 audit calibrator and allow for warm up (30 minutes)

- Log into the station laptop and access the data logger
- From the User menu, Press G to display channel identification numbers
- Press C and the ozone channel number/Q to disable the ozone channel and flag the data
- Press U to return to the User Menu
- Press T
- Press R/ozone channel number to view the current voltage output
- Open the OAMD O_3 Audit form on the field laptop
- Fill in the appropriate information including:

    g) Site Name
    h) Auditor
    i) Date
    j) Start time
    k) Analyzer calibration slope
    l) Audit and On-Site Calibrator serial numbers

- Introduce zero air to the analyzer by setting the Level 4 audit calibrator to zero
- Disconnect the incoming sample line at the manifold and cap the port
- Attach the incoming sample line to the output of the calibrator, venting if necessary
- Allow for stabilization
- Using a voltmeter, compare the Zeno output display (on the station laptop) to the voltage input from the ozone analyzer to the Zeno patch panel
- Enter the output and the calibrator zero response on the OAMD form. The Oracle spread sheet will automatically calculate the Zeno output to parts per million ozone and display the % difference between the standard and observed concentration
- Introduce a test concentration of between .190 and .259 ppm O_3 to the analyzer
- Allow for stabilization
- Using a voltmeter, compare the Zeno output display (on the station laptop) to the voltage input from the ozone analyzer to the Zeno patch panel

- Enter the output and the calibrator response on the OAMD field data form. The Oracle spread sheet will automatically calculate the Zeno output to parts per million ozone
- Introduce a test concentration of between .140 and .169 ppm O_3 to the analyzer
- Allow for stabilization
- Using a voltmeter, compare the Zeno output display (on the station laptop) to the voltage input from the ozone analyzer to the Zeno patch panel
- Display the % difference between the standard and observed concentration
- Enter the output and the calibrator response on the OAMD field data form. The Oracle spread sheet will automatically calculate the Zeno output to parts per million ozone
- Introduce a test concentration of between .070 and .089 ppm O_3 to the analyzer
- Allow for stabilization
- Using a voltmeter, compare the Zeno output display (on the station laptop) to the voltage input from the ozone analyzer to the Zeno patch panel
- Enter the output and the calibrator response on the OAMD field data form. The Oracle spread sheet will automatically calculate the Zeno output to parts per million ozone and display the % difference between the standard and observed concentration
- Reconnect the incoming sample line to the manifold and disassemble the Level 4 audit calibrator
- Allow the ozone analyzer to return to ambient conditions
- Enable the ozone channel and make the appropriate electronic operator log book entries
- Enter the audit end time on the OAMD form and save the audit results

6.0 Quality Control Measures

The quality control measures listed below are intended to further ensure high quality monitoring data and to prevent unnecessary data loss.

6.1 Zero Span Checks

Daily zero/span (.400 ppm O_3) checks of all IDEM monitoring network ozone analyzers are conducted remotely using the LEADS. This allows AMS and QAS staff members to closely track the stability of the ozone analyzers.

If an instrument does not have the LEADS or some other internal or automatic capacity, this zero/span must be done manually at least once per week. If the analyzer drifts excessively, more frequent zeros and spans will be required. Although not used specifically for data validation/invalidation, zero/span checks will help to track a monitor's drift pattern and may show at what particular point a monitor began to show a trend. If an audit exceeds the allowed percent difference and records of zero/span checks can be supplied to identify when excessive drift began, it may not be necessary to invalidate an entire operational period. Decisions on data validation are made by the QA Section Chief. See Chapter 11 of this manual for zero/span drift limits.

6.2 Site Checks

Once every two weeks physical site checks are performed by AMS staff to verify the actual operating/environmental conditions of the ozone monitoring site. Although with LEADS diagnostics can be checked remotely, it is still necessary to change the inline particulate filters and clean air scrubbers on a routine basis. Also, the site check allows for:

- Physical inspection of incoming sample lines
- Weed abatement
- Heating and air conditioning system inspection
- Safety inspection
- General housekeeping
- The condition of the sample probe line and manifold. The sample probe and manifold should be scheduled for cleaning bi-annually or be cleaned any time visible deposits of dirt can be detected. Avoid using cleaning solutions containing soap, alcohol or other products containing hydrocarbons
- Changes to the area such as ongoing construction
- Vandalism

6.3 Preventive Maintenance

Preventive maintenance is an intrinsic part of quality control. Analyzers and station calibrators must have routine preventive maintenance performed to ensure proper operation and prevent data loss or costly repairs.

Most manufacturers supply a preventive maintenance check list with the analyzer’s instruction manual. A tracking mechanism such as a computerized database or an on-site check list should

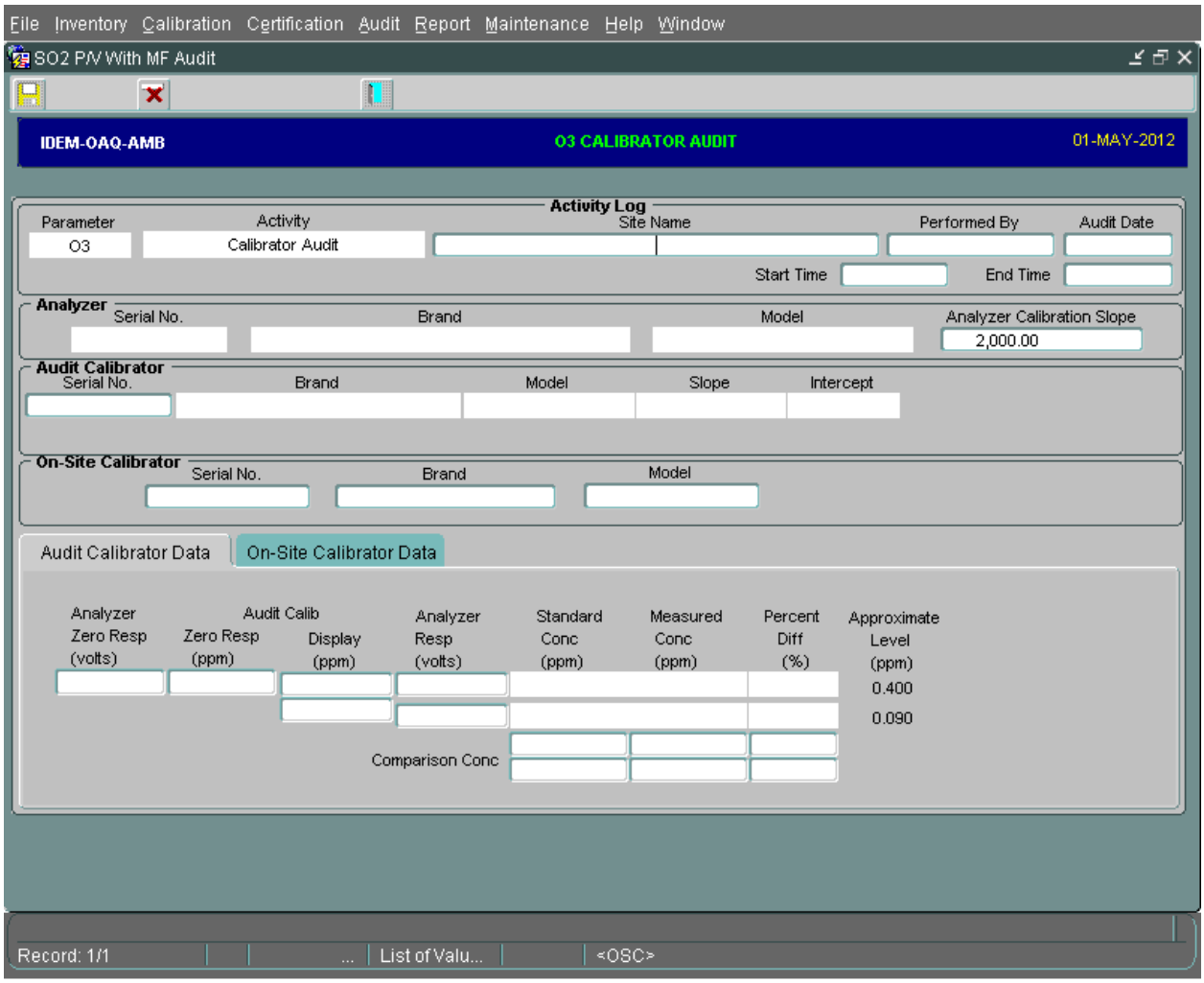
be developed to ensure all maintenance is preformed as recommended. This tracking mechanism needs to be reviewed and updated as new equipment or operating procedures are put in place.

All maintenance should be logged into the electronic or bound logbooks located at each monitoring site.

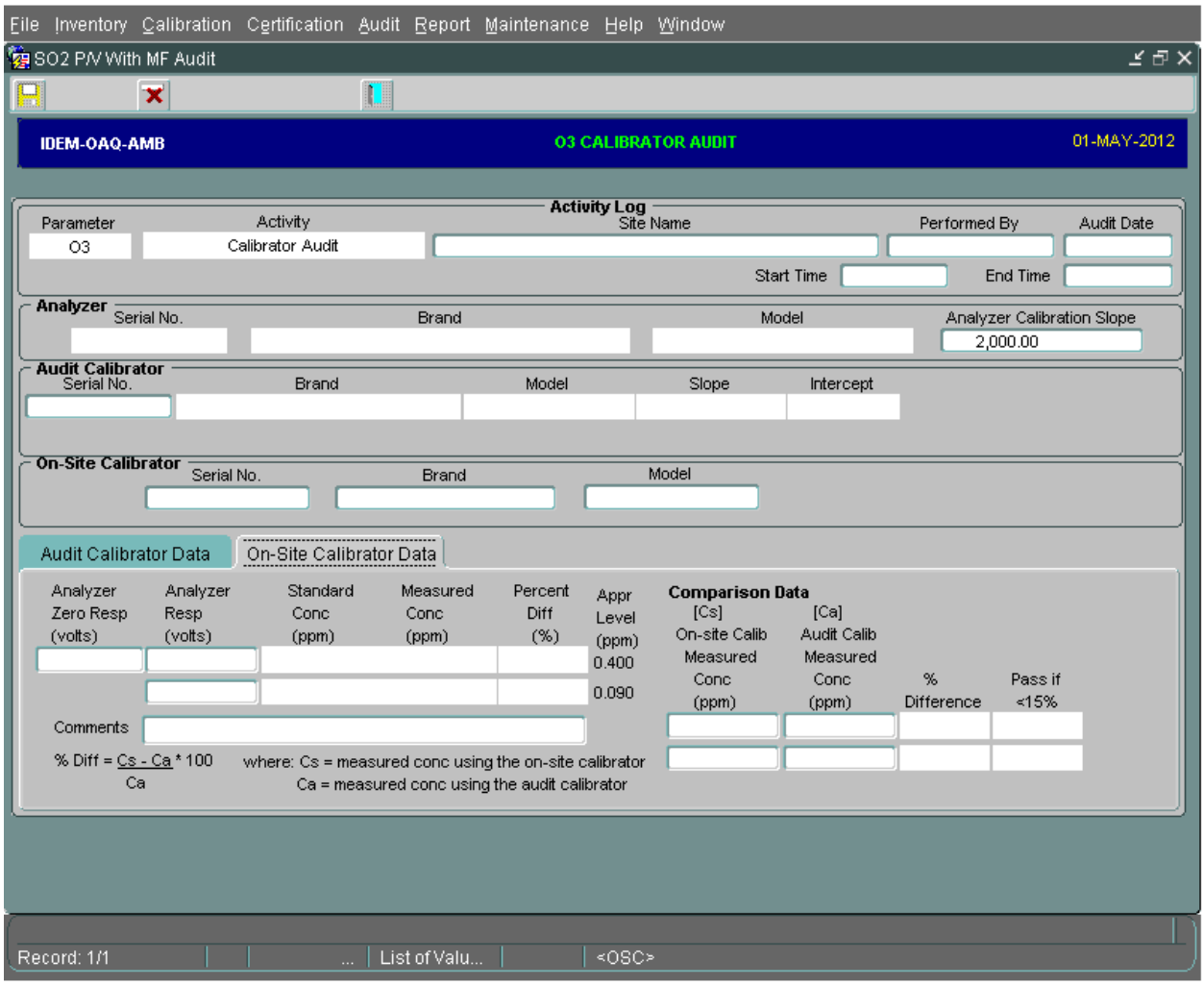
7.0 Data Reduction and Reporting

The NAAQS for ozone is based on hourly average concentration. These hourly average concentrations are done automatically via the LEADS. If this reduction must be done manually, refer to Chapter 12 of this manual for specific guidelines.

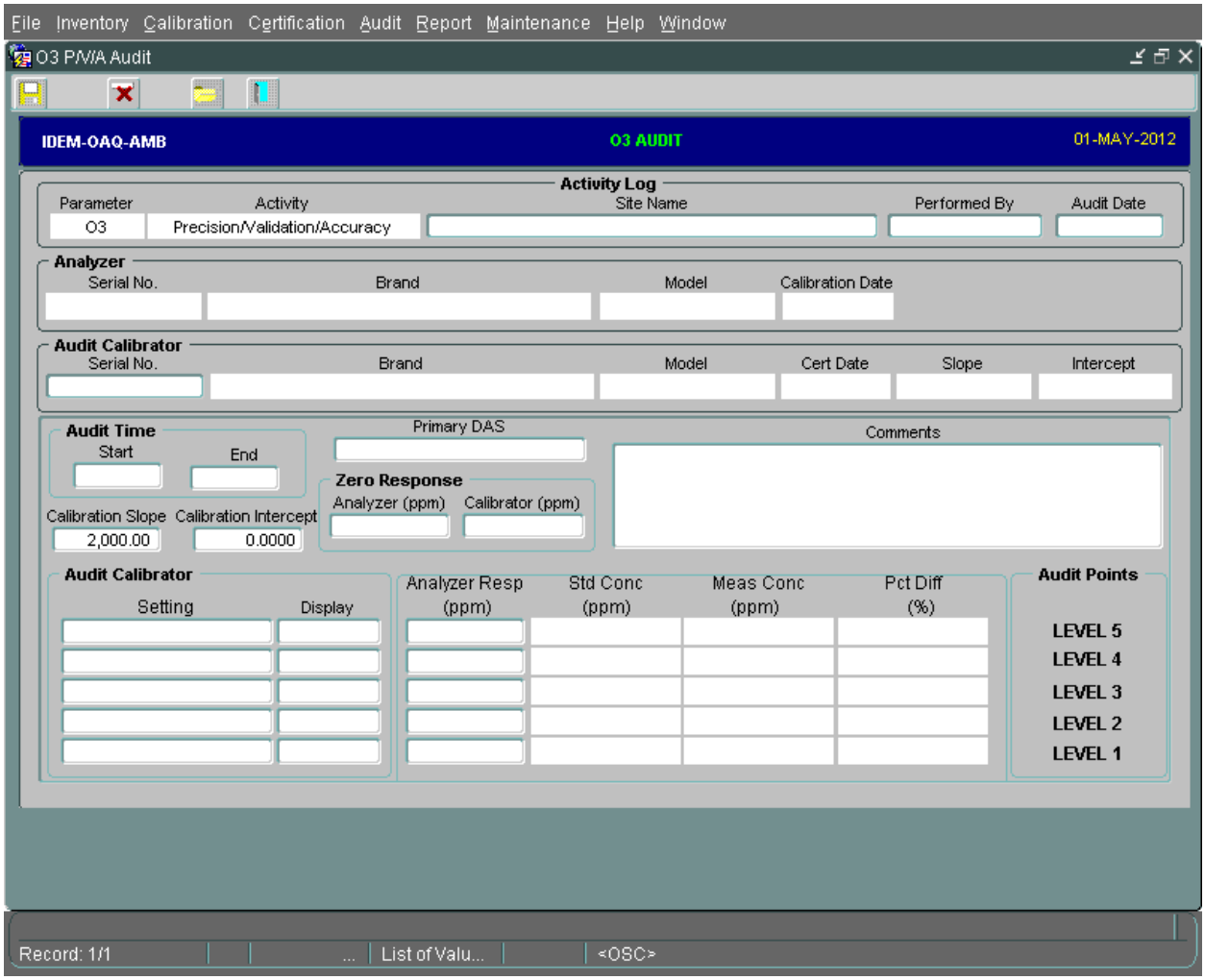
Form 1
OAMD O_3 CALIBRATOR AUDIT
Page 1



Form 2
OAMD O_3 CALIBRATOR AUDIT
Page 2



Form 3
OAMD O_3 AUDIT



Appendix 1

On-site Multi-point Ozone Calibration

There may arise special case situations which would require IDEM, an external contractor, local agency or industrial network to sample for ozone without advance monitoring or data acquisition systems (DAS). In these cases it would be necessary to perform the multi-point calibration on site using the procedure outlined in this appendix.

A data validation audit should be conducted prior to any routine recalibration. This one-point audit (.350-.450 ppm O_3) must be conducted prior to any analyzer adjustments. The purpose of the audit is to determine the validity of the data from the last audit or calibration to the present date. See Section 5.2.1 Part 1 Analyzer Audit.

Observe the following steps when performing a multi-point calibration on a UV absorption ozone monitor:

- Attach the analyzer's sample line to the vented output of the calibrator. A vented output consists of a union tee to bleed off excess pressure or an output manifold on the calibrator. If excess flow pressure is not released, the analyzer could be damaged. Adjust the zero air flow from the calibrator to the analyzer. The zero air flow must exceed the analyzer's total flow demand by at least 25% to ensure that no ambient air is pulled into the system through the vent. For example, if the analyzer flow demand is 1.0 l/min then the total output flow from the calibrator should be no less than 1.25 l/min.

- Allow for stabilization (a response is considered stable when the display does not vary more than 5 ppb over a five minute period). Using the analyzer's zero adjustment; adjust the analyzer response to read .000 mV or ppm on the data acquisition system (DAS). Record the zero response on the calibration worksheet; an example of which can be found.

- Using the O_3 standard concentration equation below and the calibrator certification information, determine the calibrator settings required to generate a concentration at approximately 80% of the analyzer's range (e.g., for an analyzer operating in the 0-.5 ppm range, .400 to .450 ppm should be used as the span concentration).

$$\text{Std. Conc. (ppm)} = \text{Slope} \times (\text{indicated } O_3 - \text{intercept})$$

  Allow the analyzer to sample until the response is stable. Adjust the span setting until the response matches the standard concentration determined in the above equation (to within ±2%).

- After the zero and the 80% of range concentration have been set, make no further adjustments to the zero or span controls. One additional, concentration must be introduced (e.g. .180 to .220 ppm is an ideal range). Record or enter the standard concentration (those introduced by the O_3 generator or photometer) and the analyzer's indicated response calibration worksheet/spreadsheet.

- Determine the calibration slope by:

    a. Using the least squares linear regression method to find the line of best fit. Use analyzer responses (in ppm) as the X values. Use the standard ozone concentrations (generated from a certified ozone generator or photometer) in ppm as Y values.

    b. Adjust the analyzer's span pot so that the slope is a fixed value (i.e., for a 0.5 ppm range: a 0.5 slope for a 1 volt output; a 0.005 for a 100 millivolt or strip chart output; a 0.0005 slope for a 1000 millivolt). All calibration concentrations must be within ±2% of the range of the monitor.

- Calculate the measured concentration using the observed concentrations and the calibration slope and intercept.

- Compare the difference between the measured and standard concentrations. If any point is outside the 2% or range limit, the calibration is considered invalid and must be repeated. If a successful calibration cannot be completed in two attempts, the instrument is considered suspect, and maintenance may be required.

Ozone Calibration Worksheet

Site:		AQS #:	
Data Status:			
Date:		Performed by:	
Start time:		End time:	

Analyzer Information

Brand/Model:			S.N.:	
Range: 0 to		ppm	Slope	

Calibrator Information

Brand /Model		S.N.:	
Certification Date:		Standard Conc. =	*(Indicated O_3 Value -)

Calibration Data:

Primary Recording Device:		S.N.:		Units:	
Secondary Recording Device:		S.N.:		Units:	

Initial Zeros:

Primary Response:		Secondary Response:		DVM response:	

O_3 Audit Information

Calib. Settings	Calib. (in ppb)	Monitor response			Measured conc. (in ppm)	Standard conc. (in ppm)	% Diff.	
		DVM Units:	Primary Units:	Secondary Units:			Primary	Secondary

Audit pot information:

Zero Pot:		Span Pot:	

Ozone Calibration Information

Calib. Settings	Calib. (in ppb)	Monitor response			Measured conc. (in ppm)	Standard conc. (in ppm)	% Diff.	
		DVM Units:	Primary Units:	Secondary Units:			Primary	Secondary

Calibration pot information:

Zero Pot: | Span Pot:

For TECO Only:										
A/B Test:										
Are the 10 averages within 3.0%? : (Circle one) Yes No										

Leak Test: | Site Temp: | Reminder: IS PSI SET IN COMPUTER?

DIAGNOSTICS

TECO					DASIBI	
Flow:	A:		B:		Flow:	
For 49:						
Noise:	A:		B:		Sample Frequency:	
Frequency	A:		B:			
Pressure:	A:		B:		Control Frequency:	
Temp:	A:		B:			
For 49C:					(Also for 1008):	
Intensity:	A:		B:		Temperature:	
Noise:	A_{ref}		A_{sam}		B_{ref}		B_{sam}			
Pressure:					Pressure:	
Bench:						
Bench lamp:						

COMMENTS

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